Space Weather Technical Forecast

Issued on Monday, 18 April 2022 at 13:07 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares Likely throughout (R1/R2 Radio Blackouts). Active Electron Fluence Likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate over the past 24 hours, with the sputtering into life of a southwestern quadrant sunspot, AR2992 generating frequent C-class and occasional M-class flares, peaking with an M4.4 at 17/2334UTC at GOES 16. The precise classification of this growing sunspot region is open to doubt given its approach to the western limb, however it appears to be a Dsi/Beta at the time of writing. The emergence of this group as the most potent was probably down to its growth trend, as the disc remains dominated areally and in terms of complexity by a large pair of spots occupying the northeastern quadrant, AR2993 and AR2994. The former's rotation revealed a trailing spot a distance from the large leading cluster - this appears to be connected in HMIBC imagery and leads to a classification of Fhi/Beta-Gamma. This group now appears to have inherited some of the potency of its immediate southern neighbour, with a late M1.1 at 18/1027UTC. While still generating flares, the latter became quieter after its X-class flare of Sunday 17 April, finishing the period as an Eko/Beta-Gamma, but with a candidate for a delta spot in its large leader that will need to be monitored.

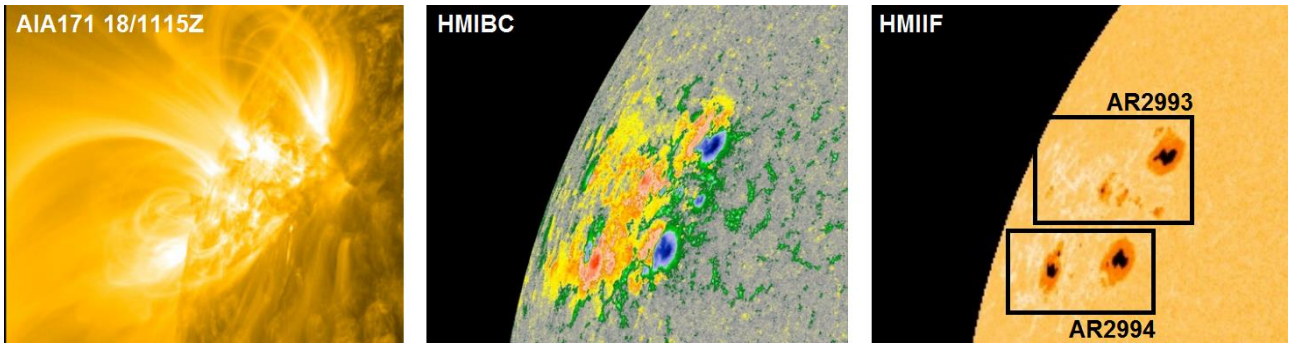

Figure 0: View of the northeastern limb sunspot cluster

There were otherwise up to three other groups on the disc, bringing the total to six, with AR2990 a stable Cro/Beta; AR2991 a unipolar Hsx/Alpha; and finally a new region to its east only attaining Bxo/Beta by the period's end.

A filament eruption was observed in the southwestern quadrant in the immediate vicinity of the destabilising influence of AR2992 at 17/1600UTC. Analysis is still underway for this event, however an Earth-directed component appears unlikely for the parameters submitted for modelling. Other Coronal Mass Ejections (CMEs) visible on coronagraph imagery appear to be low-latitude far-sided features, with no effect at Earth therefore expected.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1 showed the characteristics of a fast wind regime, perhaps also signalling a transition between positive polarity

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coronal holes 74 and 75 in the early evening UTC as the speed underwent a resurgence and the phi angle briefly faltered from an otherwise resolutely positive sector (away from the sun).

The solar wind speed showed an initial slight decline from around 500km/s into the high 400s of km/s, before a stronger rise from around 17/1900UTC to reach the high-500s by the end of the reporting period. The solar wind density showed a rise and fall about 10ppcc over the same interval, while the IMF peaked at a similar time at 11nT, allowing the north-south component the scope to range between +10 and -7nT.

The net effect of the above solar wind measures was provisionally Quiet to Unsettled Kp indices, peaking at '3o' in the 15-18UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured at GOES-16 at GEO was at Background levels throughout, despite a series of sizeable western solar hemisphere flares from AR2992.

The high energy electron flux (greater than 2 MeV) showed a hiatus in its recent rising tendency, falling from a peak of 2310pfu at 17/1705UTC to Normal Background levels into the UTC day of Monday 18 April, recovering a little to Moderate flux through the morning. The 24-hour integrated fluence showed a levelling trend in the period, remaining near the value of 5.45e7 integrated pfu seen at 18/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to be Moderate through the period, with a daily Slight Chance of X-class flares. Recently active AR2992's departure in 24 hours ought to be compensated for by the current northeastern quadrant and perhaps also by returning large regions over the northeastern horizon, giving a flat trend over the four days.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs in the current forecast. There are up to three coronal holes due in the four days, with a transition between CH74 and 75 perhaps already having occurred. This leaves CH76 as due later Wednesday 20 April. Unsettled activity is Likely, with a Chance of Active and a 5% Slight Chance of G1 for most days of the period, with Tuesday 19 April perhaps most reliably Quiet.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels, but should show a rising Slight Chance of S1 or greater in the four days, the result of westward progression of the largest spots.

The high energy electron flux (greater than 2 MeV) is relatively low confidence, with Active 24-hour fluence still considered Likely, but with onset now slightly delayed into day two, Tuesday 19 April. The dissimilarity of the current disc in terms of coronal holes and the possible presence of minor transients should serve to keep uncertainty relatively high in the period.

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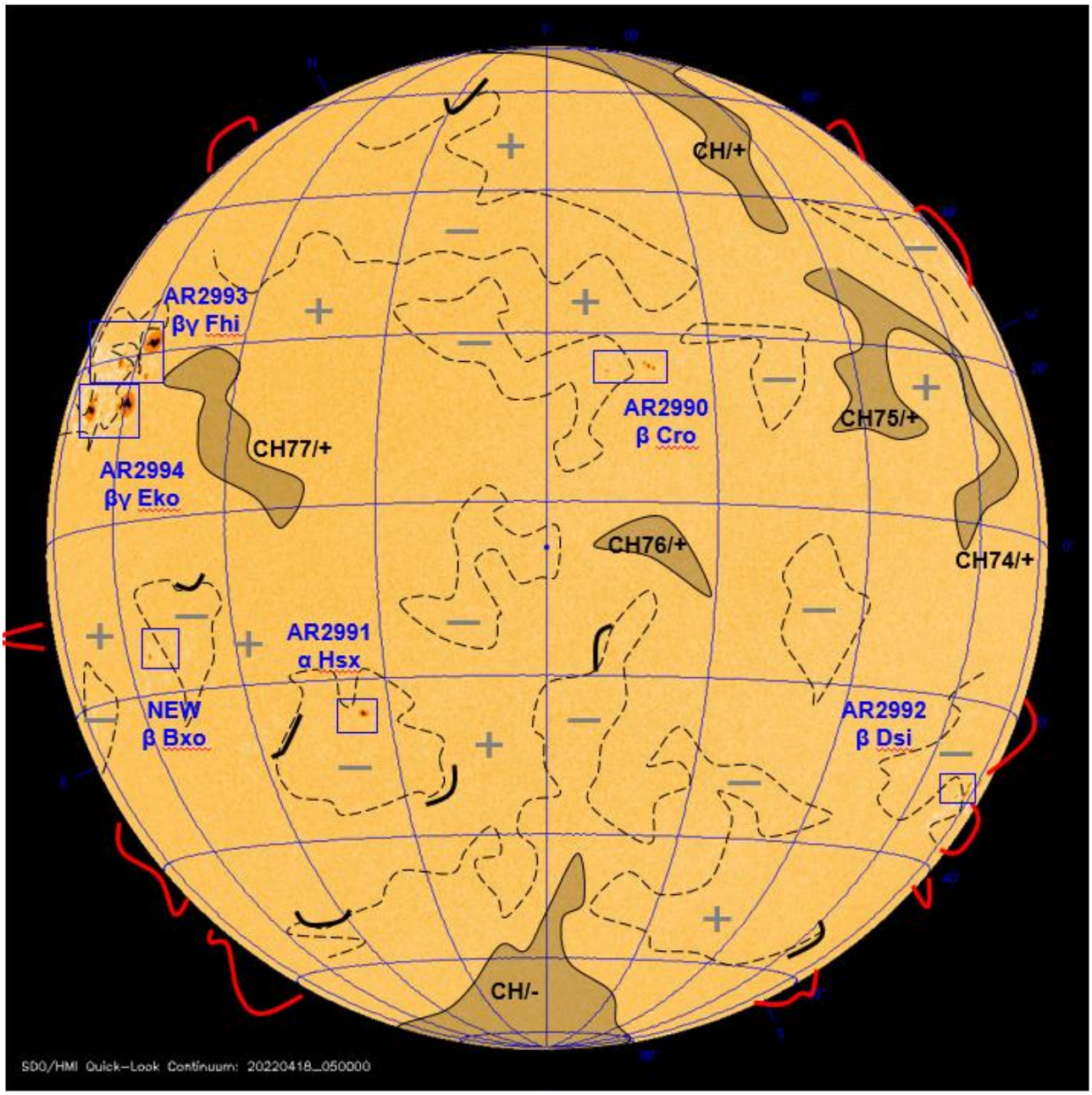
Figure 1. Solar Analysis Valid 18/0500UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs in the current forecast.

There are up to three coronal holes expected to feature in the coming four days, all of positive polarity, which ought to mitigate against the risks of G1. The influence of CH74 is now thought to have most likely passed, with a largely indistinct transition into CH75 thought to be a possible reason for the recent upsurge in solar wind speed. As regards the third coronal hole, although this corresponds to a recurrent feature, it appears to be reduced in size and is relatively less likely to represent the peak risk of geomagnetic activity in the period - only attaining an isolated Kp4 interval on last pass.

Coronagraph imagery is relatively polluted at present with numerous minor peripheral CMEs. This increases the chances of minor unforecast transients, which lessens confidence in reliably quiet to unsettled conditions for the period as a whole. The current crop of coronal holes are Likely to produce Unsettled activity, with a Chance of Active. CH76 may now be starting to manifest at STEREO A, which puts an 'arrival' time at Earth of late Wednesday 20 April into Thursday, with an intervening lull between this and forerunning CH74/75.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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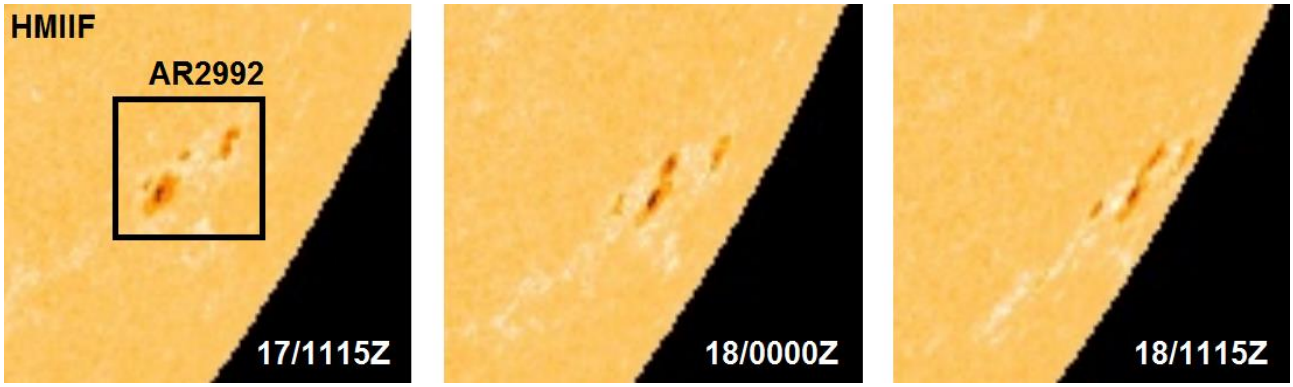
Radio Blackouts - X-Ray Flares:

Solar Activity is expected to be Moderate, with further M-flares (R1/R2 Radio blackouts) Likely each day, primarily from the cohort of large active regions in the northeast. Although these groups appear to be going through something of a quiescent phase, they remain magnetically complex, with AR2994 perhaps showing evidence of a large Mt Wilson delta spot in its leading group (to be confirmed when the viewing angle improves). In addition to this, AR2993 appears to have a trailing spot at some distance from the leading cluster, giving it an impressive span of 19 degrees and Fhi/Beta-Gamma Zurich classification. Somewhat against the run of play, AR2992 in the southwest proved to be the most potent spot of the period, however this too is hampered by the viewing angle, and detail within is likely to be increasingly difficult to discern. Although it has proved very capable of frequent C an M-class activity, barring significant development, its frequent discharging of energy may prevent still larger flares from being generated.

All considered, M-class flares are considered Likely throughout, with a daily Slight Chance of X-class. The balance of front side groups should remain fairly constant, as while AR2992's departure in 24 hours' time is expected to reduce the risk of further large flares, this may well be compensated by the return of northeast limb bright flux regions seen in STEREO A EUVI 195 imagery around the same time.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	75	75	75	75
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 2: Time sequence in HMIIF of evolution of AR2992 over the past 24 hours. Note that detail is becoming increasingly difficult to discern, but there appears to be interaction between the two intermediate spots, which are of opposing polarity.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at Background levels, and is most likely to remain so through the next four days.

Having said this, the flaring into life of AR2992 in the southwest quadrant as well as the looming presence of numerous large sunspot regions in the northeast does increase the risk of S1 or above with time, perhaps still further should there be further large returning regions in the northeast. There is therefore a very gradually increasing daily Slight Chance of exceeding S1, although as yet AR2992 has yet to prove its mettle in this respect, and the large regions are a little far eastward to fully bring their weight to bear on the probabilities.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 at GEO had risen to a higher baseline in the past 24 hours to peak at High levels, however this trend is being interrupted by a concurrent slight upturn in geomagnetic activity, perhaps related to a transition between coronal holes 74 and 75. It remains the case that exceeding 24-hour integrated fluence is Likely in the period, especially after the current upper-500s of km/s high speed stream matures, however the onset of these conditions is now delayed a little into the coming UTC working week.

MOSWOC REFM is suggesting a slight rising trend in the period, however the current solar wind speed is a notable departure from persistence, and the upcoming persistent coronal hole 76 is a shadow of its former self in terms of area. This taken along with the fact that there are numerous minor transients being generated by the sun at present all serve to lower confidence in the forecast, with an initial Chance of Active rising slightly to become Likely from day two, Tuesday 19 April, but with the probabilities of Active 'near-evens' throughout.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	40	60	60	60
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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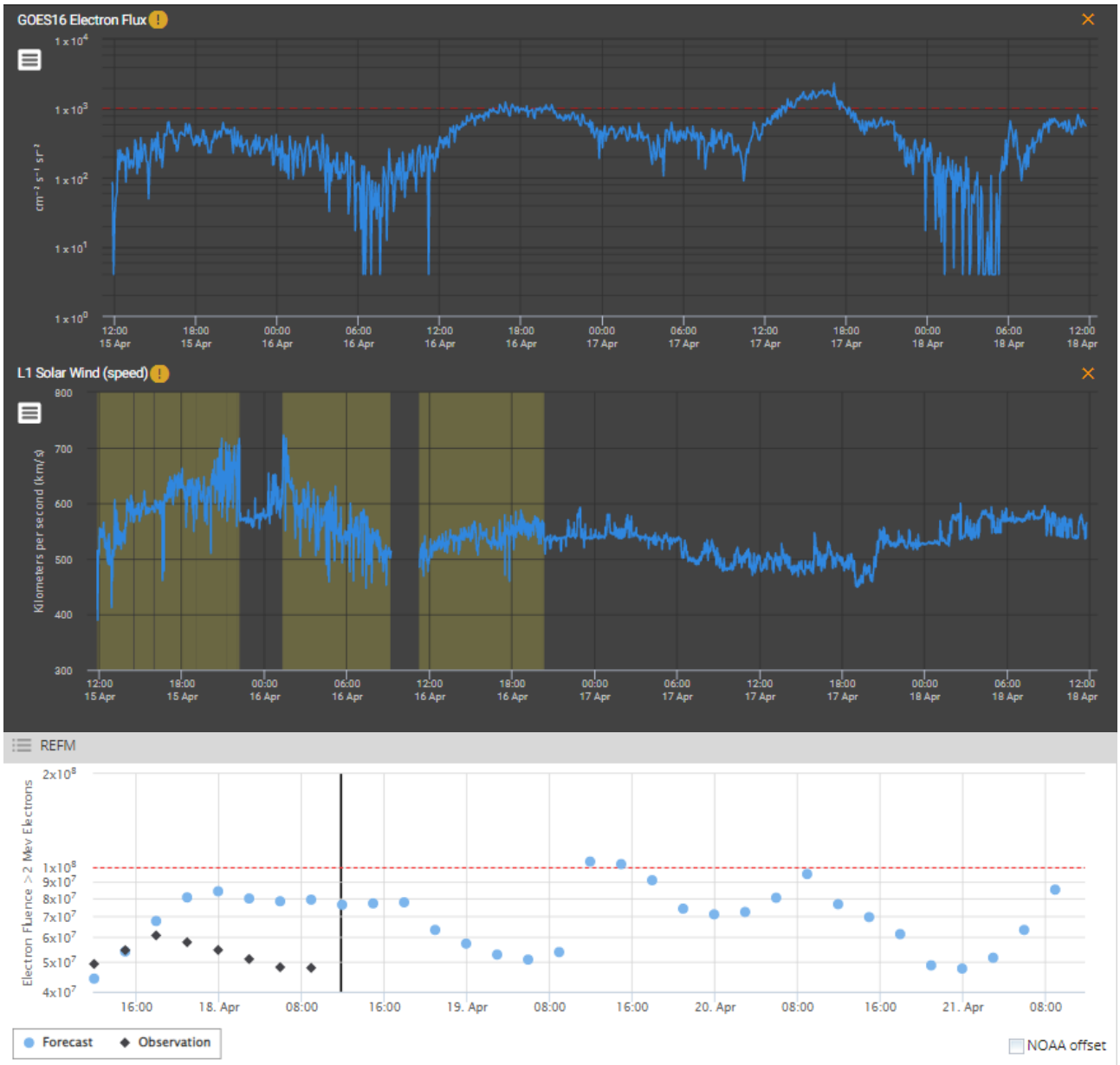
Figure 3: Top and middle: past 72 hours in GOES 16 high energy electron flux and L1 solar windspeed. Bottom: MOSWOC REFM is proving volatile for the period, in part given the difference between current observations and those experienced on last rotation, but also because of the somewhat erratic current solar wind and geomagnetism.



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